

## BOARD PRODUCT AND METHOD OF MAKING THE SAME

### BACKGROUND OF THE INVENTION

#### Field of the Invention

Embodiments of the present invention relate to a coated board product and a method of producing the same.

#### 5 Description of Related Art

In the field of producing paper products, one ongoing goal is to improve the quality of board products, especially SBS board, and the economy of producing the same.

Packing board is required to have a certain surface quality for ensuring a desired gloss and print quality, a stiffness and tear resistance for securing the functionality of a  
10 package. Since board is produced in large quantities in a board mill, the efficient use of raw material is also important. However, these demands are somewhat contradictory to each other. Board can be provided with a sufficient gloss by calendering the board by compressing it in a nip, often moistened and heated in a certain manner. The surface  
15 fibers and coating of board are preferably pressed smooth by this compression, yet without compacting the middle ply of board. The compaction of a middle ply undermines board stiffness and reduces tear resistance. This compaction of a middle ply is often referred to as a loss of bulk. In this case, bulk is understood as being an inverse value to density and a loss thereof is thus equal to a densifying compaction of paper or board.

20 Since the process of making paper and board is highly raw material intensive, even a minor saving in raw material provides a major advantage over competitors. In this respect, a saving of just one percent can be considered a major competitive edge and the investment restitution time is short. Saving raw material is also desirable for

environmental reasons. By virtue of a reduced weight structure, the multiplicative effects of the board of this invention cover the product's entire life span, the reduced consumption of raw material resulting in a lighter package which ultimately creates savings also in shipping operations and in the way of a reduced amount of waste.

5           Packing boards are often coated and have a multi-ply structure. SBS boards (solid bleached sulphite/sulphate), intended for food application and for packing cosmetics and cigarettes, are manufactured from pulp. They can have one or more fiber plies coated with a suitable agent for conditioning surface properties. If the board consists of several plies, it is possible to use chemical pulp and/or own broke in the body ply. A typical  
10       basis weight range for boxboards is 150-400 g/m<sup>2</sup>. The necessary basis weight depends on a required stiffness of the package, a lighter board being sufficient for small boxes. Successful conservation of board bulk in surface treatment to produce thereby board of a higher stiffness results in savings of raw material and energy by enabling the use of board of a lesser basis weight.

15

#### BRIEF SUMMARY OF THE INVENTION

The above and other needs are met by the present invention which, in one embodiment provides a method of making a boxboard product with a flat printing surface, and a high gloss and stiffness in the boxboard with a lesser-than-before  
20       consumption of material. In one embodiment, a coated packing board comprises two or more fiber plies, wherein the outside plies consist of bleached chemical pulp and possible middle plies of chemical pulp or broke. A typical application comprises food packages and cigarette packages. The board is required of good printing qualities, lightness, stiffness, and in the case of liquid board, the board is further treated for waterproofness.

25           FBB (folding boxboard) and other boxboards are often smoothed prior to coating with a Yankee cylinder, which enables a good bulk and stiffness, the surface properties being also good, the drying shrinkage along the edges being likewise small, yet the use of a Yankee cylinder is limited by speed restraint, space demand for equipment and the enormous size of a Yankee cylinder in a high-speed machine. Another typical treatment  
30       method involves a wet-stack calender, the drawbacks of which include problems

regarding runnability and a controlled application of water and, in addition, extra costs are incurred by the necessity of drying SBS board before and after a calendering process.

A machine calender is often used together with other calenders, the machine calender referring to a hard calender with no elasticity in its rolls. The use of a machine  
5 calender as the sole surface treatment method is generally not advisable. A soft calender refers to a soft-nip calender, wherein the calender roll has a surface which is elastic, the surface having possibly a hardness in the same order as the surface hardness of wood, yet being elastic.

According to the invention, boxboard is treated with a long-nip calender prior to  
10 or during a coating process. A long-nip calender suitable for making a board of the invention has been described, for example, in U.S. Patent No. 6,164,198 also assigned to the assignee of the present invention.

A calender suitable for the surface treatment of a board of the invention includes a fixed support element, around which is a tubular jacket. A heated counter element is  
15 disposed on the other side of the tubular jacket from the support element, such that a web passes through between said counter element and the tubular jacket. The fixed support element is provided with load elements, applying the jacket against the heated counter element and thereby enabling a calendering process between the jacket and the counter element. The jacket has its opposite ends secured to end walls mounted rotatably relative  
20 to the support element, the rotary motion of the end walls being delivered by a separate drive motor, which is independent of a motion of the fiber web in order to avoid overheating of the jacket.

A method of the invention for conditioning the surface of coated or uncoated board with a surface conditioning device is in turn characterized in that the method  
25 comprises feeding a fiber web through a long nip established by a roll and a counter-roll, the former being in the form of a tubular-shaped flexible jacket. Across the extent of the nip the jacket deflects and thereby presses into contact with the counter-roll over a long stretch. The board treated with the method is lighter than currently available boards, while stiffness and surface properties are equal to those of currently available boards.

The solution enables a running speed substantially higher than what is accomplished with a Yankee-cylinder equipped board machine. In addition, the runnability is better, this also contributing to improved quality and reducing waste.

Web speed in the calender may be higher than 350 m/min, preferably higher than 600 m/min, and still more preferably 1000 m/min, yet lower than 4000 m/min. Thus, the calender does not restrict the speed of a board machine. The above-mentioned heated roll has a temperature of 150-350°C, preferably higher than 170°C, most preferably about 200-250°C. Linear pressure in the nip is within the range of 100-500 kN/m, preferably less than 400 kN/m. Maximum pressure in the nip is 2-15 MPa, preferably less than 13 MPa.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

**FIG. 1** is a sectional view of a long-nip calender, provided with a long nip between a shoe calender and a counter-roll;

**FIG. 1A** is a partial enlargement of **FIG. 1**;

**FIG. 2A** is a partial sectional view of the device shown in **FIG. 1**, along the roll axis depicting a drive mechanism.; and

**FIG. 2B** shows the operation of press shoes in a longitudinal section.

#### DETAILED DESCRIPTION OF THE INVENTION

The present inventions now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the inventions are shown. Indeed, these inventions may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

As shown in **FIG. 1**, a board web **80** travels through an extended and heated nip **1**. The nip **1** is established by an enclosed shoe roll **10** present under the web **80**. Above the web **80** is a heatable counter-roll **22**. The enclosed shoe roll comprises a flexible

jacket 12 impervious to liquid. The jacket consists for example of fiber-reinforced polyurethane. A stationary fixed support element 14 carries at least one load shoe 18. Between the load shoe 18 and the support element is an actuator 20, such as a hydraulic cylinder, for urging the concave load shoe 18 and thereby also the flexible jacket 12 against the counter-roll 22. Thus, the jacket 12 is forced out of its normal unloaded position 11 in a direction away from the center of the enclosed shoe roll. The jacket 12 is fastened at both ends thereof to end walls 24, 26, thus creating a sealed compartment 13 (see FIG. 2). As shown also in FIG. 1, at least one detector device 99 is mounted in communication with the web 80 for detecting web breaks. The detector device 99 is connected to a control device 98 for controlling the operation of a calendering process in dependence of the web being broken or not.

As shown in FIG. 1, the heatable counter-roll 22 is accompanied by a disengagement mechanism, comprising a lever 95 pivotable by a hydraulic cylinder assembly 94 and provided with a pivot point 96 for pivoting the lever thereon. The disengagement mechanism presses the counter-roll 22 to an engagement with the nip 1 and disengages it from the nip 1.

Between the load shoe 18 and the jacket 12 is supplied a pressurized oil, which develops a hydrostatic pressure throughout the nip and presses the jacket to an engagement with the counter-roll 22 over the entire extent of the nip 1. At the same time, the oil protects the jacket from being damaged by lumps and a temperature rise.

In FIG. 2A it is shown that the end walls 24, 26 are rotatably mounted on stub shafts 16, 17 of the support element 14 (The end walls are preferably not integral but divided into a static part and a rotating part as shown in FIG. 2B). On one end of the stub shaft, a cylindrical shaft 32 is arranged rotatably via bearings 34. A support column 36 is arranged to the cylindrical shaft via self-aligning bearings 38, which allow spherical movement to allow the deformation/bending of the support element 14 when heavily loaded. One of the end walls 24 is fixedly attached to the cylindrical shaft. A drive transmission 40 is fixedly attached to the cylindrical shaft outside the end wall, in the shown embodiment a cog wheel. The cog wheel is connected to a transmission 42 and in turn a drive 44. A cog wheel 46 is fixedly attached to the cylindrical shaft inside the end wall. A drive shaft 48 is arranged inside the jacket and parallel to the support element 14.

The drive shaft 48 is supported by bearings 50 arranged in bearing houses 52 attached to the support element. At each end of the drive shaft, cog wheels 54 are arranged.

Preferably these cog wheels have a prolonged toothed portion to allow axial movement of the intermeshing cog wheel which is attached to the end wall. A further cog wheel 56 is  
5 fixedly attached to the second end wall 26 inside the jacket. Both cog wheels inside the jacket mesh with the corresponding cog wheel on the drive shaft. The second end wall 26 is rotatably arranged on the second stub shaft 17. The second stub shaft is in turn fixedly attached to a second support column 58.

The operation is as follows. During normal operation, the driven heated roll 22 is  
10 in interaction with the fiber web and the flexible jacket 12 by a desired pressure being exerted by the load shoe 18, thereby causing a friction based drive of both the fiber web and the flexible jacket. Accordingly, during normal operation the forces exerted in the nip provide for rotation of the enclosed shoe roll.

Only in specific occasions, it will normally be desirable to operate the  
15 independent drive of the enclosed shoe roll 10, for example, when starting up the calender. If the calender should be started without first speeding up the flexible jacket 12, this would inevitably cause damage to the flexible jacket due to overheating. Furthermore, it would also be deteriorating for the fiber web, since at the moment of start it would develop exceptional tension forces in the fiber web. Accordingly, the  
20 independent drive arrangement of the enclosed shoe roll is to be used for instance at the start-up of the calendering surface. At the start, the nip gap is not closed, but the roll 22 has been moved out of contact with the nip 1. Before moving the heated counter-roll 22 into the nip, the drive arrangement 44 of the enclosed shoe roll 10 is activated to accelerate the first end wall 24 via transmissions. The rotation of the end wall causes the  
25 inner first cog wheel 46 to rotate, and subsequently the drive shaft 48. The drive shaft transmits the rotation to the second end wall 26 via the second inner cog wheel 56. The both end walls are thus accelerated and rotate at the same speed until a desired peripheral speed is obtained, which is normally equal to the speed of the fiber web. The nip is closed by activating the hydraulic piston 94 to pivot the lever 95 and thereby moving the  
30 counter-roll 22 into the nip and subsequently the load shoe 18 is urged against the heated roll 22 by its actuators 20. Once the calender functions in the desired manner, the drive

arrangement of the enclosed shoe roll can be deactivated and the press roll driven in a conventional manner by friction within the nip 1.

In FIG. 2B there is shown an alternative embodiment of the drive arrangement for an enclosed shoe roll. This embodiment uses friction for the transmission of rotational forces.

FIG. 2B also shows a design of arranging the support element and the end walls. The end walls are divided into inner parts 24A, 26A connected non-rotatably to the support element 14, a rotational part 24B, 26B, and a bearing assembly 24C, 26C therebetween. The support element 14 is at its ends arranged with self-aligning bearings 23, 25 to allow a deflection of the support element 14.

In the figure there is shown a drive 44 having a shaft 19B. On the shaft 19B is mounted a disc 19 having a rubber ply at its peripheral end 19A. The outer ends of the flexible jacket 12 are fixedly attached between an annular ring 15, acting as a replaceable force transmitting device, and the periphery of each end wall. The ring 15 is fixedly attached to the end wall. On the inside of the rotational part 24B, 26B of each end wall there is fixedly attached a cog wheel 46, 56. The drive arrangement 44, 19 is movable in and out of contact with the force transmitting device 15. When it is desired to accelerate the enclosed shoe roll 10, the drive arrangement is moved such that the rubber ply 19A comes into frictional engagement with the force transmitting device 15. The cog wheel 46 and the drive shaft 48 transmit the rotation of the end wall 24 to the other end wall 26 by the cog wheels 54, 55 and 56, which at the same time function as a synchronizing device. Hence, both end walls 24, 26 are operated as described in reference to FIG. 2A. FIG. 2B further illustrates in a schematic view one functional embodiment of the load shoe 18. Generally, the load shoe 18 is not disposed diametrically relative to the drive shaft, but perpendicularly as in FIG. 2A.

Tests conducted by the assignee indicated that, in test batches manufactured by a long-nip shoe calender as described above, the board could be provided with a ratio of bulk and smoothness better than in currently available types of board. Thus, according to measurements, the goals of the invention are achieved.

Shoe calenders can be driven at high speeds and, furthermore, by the application of an elevated temperature, e.g. about 250°C, and by taking into account a long dwell

time in the calendering zone, the resulting smoothness finish will be equal to what is achieved in a slower solution using a Yankee cylinder. In addition, the board is provided with improved bulk. In addition to aspects contributing directly to board quality, the results include savings of production space in a mill, the elimination of a production limiting Yankee cylinder, and the provision of a more manageable, more easily controlled system.

In view of producing board of the invention, surface moistening can be provided prior to calendering. However, the inventive board can also be produced without surface moistening.

In the conducted test runs, the inventive board showed better bulk preservation than prior known boards and at the same time the surface properties improved when compared to prior known and commonly manufactured surface-treated boards. In addition to improved board quality, the processability will be improved and this usually improves quality. Furthermore, the capacity of a board machine may be increased as a long-nip calender is not speed restricted. Equal stiffness was achieved with a considerably lesser use of material, the difference from the board made from the same pulp in the same board machine being disclosed in the following table:

Methods Measured For The Same Grade Of Board

Final Coating Measurement Test Number	Method
1	Wet-stack(ref) 1
2	Wet-stack(ref) 2
3	hard (250°C, 40kN/m)
4	VIB + shoe
5	hard (200°C, 40kN/m) + VIB + shoe
6	VIB + shoe + hard (70°C, 40kN/m)
7	VIB + shoe both sides
8	VIB + hard (70°C, 40kN/m) + shoe
9	hard (70°C, 40kN/m) + VIB + shoe



VIB = moistening device manufactured by V.I.B (Vereinigtes Ingenieur Büro/United Engineering Office)

shoe = long-nip shoe calender suitable for making board of the invention

hard = machine calender or hard calender

5 wet stack = wet-stack calender

Tested methods provided the following results after final coating, the samples being allowed to air-condition for 1-2 hours before measurements:

Test number	Thickness	basis weight g/m <sup>2</sup>	density kg/m <sup>3</sup>	Bulk cm <sup>3</sup> /g	PPS µm	Bendtsen ml/min	Zehntner Gloss %
1	280	235	838	1.19	0.79	172	43
2	283	235	831	1.20	0.80	174	45
3	306	239	781	1.28	0.96	324	44
4	317	238	750	1.33	0.85	480	42
5	313	239	764	1.31	0.83	404	42
6	297	237	799	1.25	0.88	309	42
7	295	238	808	1.24	0.79	65	43
8	307	240	780	1.28	0.85	430	42
9	307	237	771	1.30	0.84	450	42

10

Measurements 1-2 are board grades manufactured according to traditional methods, the question being about samples precalendered and coated from board produced by the same machine, which are manufactured in pilot conditions. Thus, the presented measuring results are preliminary product development results.

15

Thus, plenty of bulk was saved when compared to the use of a wet-stack. Moreover, the surface was smoother, particularly measurement 7 is smoother than others, yet bulk is clearly better than the result achievable with a wet-stack calender. The obtained saving of bulk hence represents better stiffness with equal material consumption and, thus, in practice, the board manufacturer is able to save the corresponding amount of

material. Indeed, based on experience, the interpretation of test results represents a major step forward, regarding for example the quality of boxboard and economy of production. In general, pilot tests provide results are somewhat less indicative than those achieved in the ultimate environment, so even on the basis of these preliminary tests, it is possible to  
5 draw a conclusion that the method is capable of producing a grade of board that has not been producible before. In addition, the method is applicable to considerably higher speeds than a Yankee cylinder or a wet-stack.

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit  
10 of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of  
15 limitation.